Structural Health Monitoring 2007:

Quantification, Validation, and Implementation

Final Report - 11/30/07

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14. ABSTRACT

The theme of the 6th International Workshop on Structural Health Monitoring is "Quantification, Validation, and Implementation." The SHM community needs to work together to develop adequate quantification, validation and implementation procedures along with methodologies for SHM to lead to a successful implementation road map. The 6th IWHSM workshop afforded a fair assessment of the current SHM technology readiness in terms of quantification, validation, and implementation, and produced a consensus among the participating industries and government agencies on the need for standardized procedures and methodologies for SHM implementation, as well as the identification of key fundamental technology gaps for the research community to pursue.

The IWSHM proceedings of 2007 included the latest developments in key technology fields in sensor development, network design, signal processing, diagnostics, modeling and prognostics, system design, and applications in aerospace, civil infrastructures, machining, ground/offshore and marine structures supplied by the experts in the various fields/

15. SUBJECT TERMS

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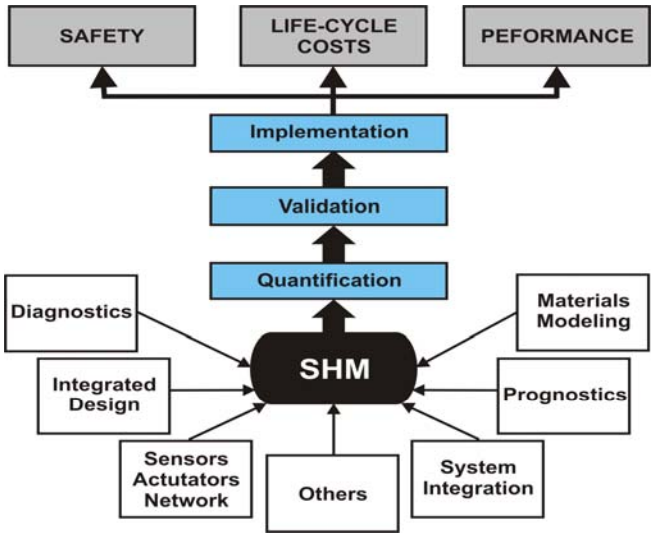
Summary

Safety, performance and life cycle cost are the major concerns in the operation of structures that are in service, especially civil infrastructure and transportation. As demonstrated, structural health monitoring (SHM) provides a solution that addresses all these concerns. SHM technologies involve multi-disciplinary engineering and require in-depth developments from each engineering field as well as system-wide integration to optimize performance.

Since the first the International Workshop on Structural Health Monitoring (IWSHM) in 1997, the progress in the development of SHM technologies has advanced significantly as can be seen from the proceedings of the biennial meetings. More than 1000 papers in topics ranging from sensor and actuator design, sensor network communication, diagnostics, signal processing, prognostics, to integrated design and system integration have been presented and discussed extensively. Numerous prototypes and field trials were demonstrated and presented successfully, especially in the meetings of 2003 and 2005.

Although continuing the fundamental development of SHM is still very much needed and



crucial for the advancement of SHM technologies, implementation of the current technologies for practical applications is being widely considered and is in progress among the industrial and government sectors, especially in the aerospace and civil infrastructure industries. However, implementation of SHM technologies requires the integration of sensor/actuator networks with the structures, which makes the process very much different from that of traditional NDE or other inspection techniques. Appropriate SHM-system design procedures and validation methods must be developed to quantify the integrated system in order to assure the highest reliability and accuracy.

Therefore, the theme of the 6th International Workshop on Structural Health Monitoring is **"Quantification, Validation, and Implementation."** Similar to the NDE community, the SHM community needs to work together to develop adequate quantification, validation and implementation procedures along with methodologies for SHM to lead to a successful implementation roadmap as shown in Figure 1. We hope that by the end of the 6th IWHSM workshop we will reach a fair assessment of the current SHM technology readiness in terms

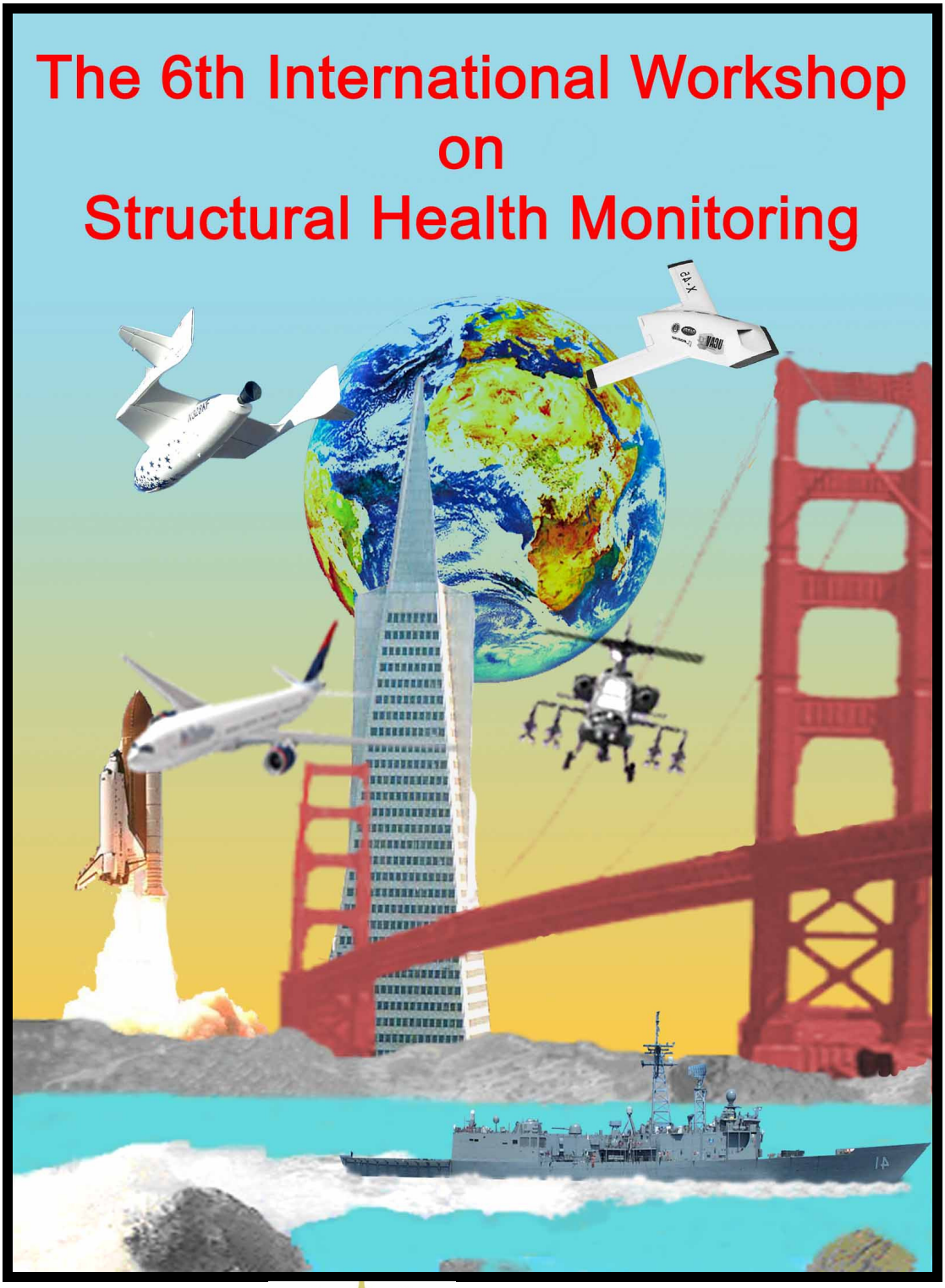
of quantification, validation, and implementation, and produce a consensus among the participating industries and government agencies on the need for standardized procedures and methodologies for SHM implementation, as well as the identification of key fundamental technology gaps for the research community to pursue.

The IWSHM proceedings of 2007 include not only the latest developments in key technology fields in sensor development, network design, signal processing, diagnostics, modeling and prognostics, system design, and applications in aerospace, civil infrastructures, machining, ground/offshore structures, marine structures, etc., but also include special sessions organized by experts in the fields on the following issues:

- Bio-inspired Sensor Networks by Akira Mita, Keio University, Japan
- Wave Propagation Models in Damage Assessment by Wieslaw Ostachowicz, Polish Academy of Science, Poland
- Emerging Sensing Technologies by Francesco Lanza di Scalea, UCSD, USA
- Ground and Air Vehicle Application by Doug Adam, Purdue University, USA
- Energy Harvesting by Dan Inman, Virginia Tech, USA
- Monitoring of Wind Energy Plants by Claus-Peter Fritzen, University of Siegen, Germany
- Civil Health Management by Emin Aktan, Drexel University, USA
- SHM for Structural Repair by Alfredo Guemes, Universidad Politecnica De Madrid, Spain
- HUMS for Rotorcraft Usage Credits by Dy D. Le, FAA
- Challenges and Lessons learned in SHM Applications by Mark Seaver, Naval Research Lab, USA
- Self-Diagnosis and Calibration Issues for SHM by J.B. Ihn, Boeing Company, USA
- Damage Quantification Methods for Aerospace Structures by J.B. Ihn, Boeing Company, USA
- Autonomic Structures by Dan Inman, Virginia Tech, USA

This workshop was co-sponsored by the Air Force Office of Scientific Research (Les Lee, Victor Giurgiutiu), the Army Research Office (Bruce LaMattina, Gary Anderson), the Office of Naval Research (Ignacio Perez, Shah Mahmood), and the National Science Foundation (Shih-Chi Liu). It was successfully organized and more than 400 people from around the world participated the meeting. A two-volume proceedings was produced. The topics and the workshop activities are outlined in the following:

The 6th International Workshop on Structural Health Monitoring



Stanford University, Stanford CA

September 11-13, 2007

http://structure.stanford.edu/workshop

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11:20 ~ 11:40	Samuel Kuhr, James L. Blackshire, Steven A. Martin, Jeong K. Na, University of Dayton Research Institute, Air Force Research Laboratory, NDE Comp. Consultants	
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	Continuous Monitoring for Performance Evaluation of the Dynamic Response of the School of Engineering Main Building at University of Naples Federico II	p. 371
15:25 ~ 15:45	Zengrong Wang and K. C. G. Ong, National University of Singapore	
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	Structural Shape Identification of Composite Structures Using Embedded Optical Fiber Sensors	p. 695
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15:25 ~ 15:45	Raimund Rolfes, Stephan Zerbst, Gerrit Haake, Johannes Reetz, , Jerome P. LynchUniversity of Hannover **Integral SHM-System for Offshore Wind Energy Turbines Using Smart Wireless Sensors**	p. 1889
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10:20 ~ 10:40	Ichiya Takahashi, Yusaku Ito, Shin-ichi Takeda, Yutaka Iwahori, Shigeki Yashiro, Junji Takatsubo, Nobuo Takeda, The Univerity of Tokyo **Debonding Detection in Scarf-Repaired CFRP Laminates Using Lamb-Wave Visualization By Generation Laser Scanning Method**	p. 2015
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	Numerical Simulation of Damage Location Tracking: Towards Decentralized Wireless Sensor System	
14:00 ~ 14:20	Tadeusz Uhl, Artur Hanc, Bart Peeters, Edgar Moya, Herman Van der Auweraer, Univeristy of Krakau, Energocontrol, LMS International	p. 1231
	Bridge Monitoring System Using Wireless Sensor Network – Hardware Solution and Preliminary Tests	
14:20 ~ 14:40	Stefan Deix and M. Ralbovsky, Arsenal research	p. 1239
	Intelligent Sensor Networks - The future in SHM?	
Diagnostics: III Chair: Jennifer Michaels, Georgia Tech, USA Room 205		
13:00 ~ 13:20	J. T. REINKING, B. E. SAWYER, A. CORDER and T. K. OOI, Welkin Sciences and MDA	p. 614
	Structural Health Monitoring of Missile Communications Ground System	
13:20 ~ 13:40	Robert X. Gao and Ruqiang Yan, University of Massachusetts Amherst	p. 598
	Wavelet Packet Transform-Based Hybrid Signal Processing for Machine Health Monitoring and Diagnosis	
13:40 ~ 14:00	Jyrki Kullaa, Helsinki Polytechnic Stadia	p. 606
	Sensor Fault Identification and Correction in Vibration-Based Multichannel Structural Health Monitoring	
14:00 ~ 14:20	Stavros Gaitanaros,Gregory Karaiskos,Costas Papadimitriou,Nikolaos Aravas, University of Thessaly,Volos,Greece	p. 653
	Crack Identification in Structures Using Optimal Experimental Design	
Integrated SHM Design II Chair: Michael Bannister, CRC, Australia Room 203		
13:00 ~ 13:20	Dr. Hans-Juergen Schmidt, Bianak Schmidt-Brandecker, AeroStruc - Aeronautical Engineering	p. 762
	Design Benefits in Aeronautics Resulting from Structural Health Monitoring	
13:20 ~ 13:40	Kyle Mitchell, Sauvik Banerjee, Beshara Sholy, Saint Louis University	p. 746
	Wireless Acquisition System for Automated, Near Real-Time Structural Health Monitoring Using Ultrasonic Sensors	
13:40 ~ 14:00	E.M.MUGAMBI, K. KWAN, B. C. LASKOWSKI, T. K. OOI and A. CORDER, Aaron Corder, Analatom Incorporated, Missile Defense Agency and Office of Naval Research	p. 730
	MEMS Based Strain and Corrosion Sensors for Structural Health Monitoring	
14:00 ~ 14:20	D. Soffker, K. Wolters, M. Ozbek and K. -U. Dettmann, Dynamics and Control	p. 754
	Feature-based Diagnosis and Prognosis for an Integrated Diagnostic Approach	
14:20 ~ 14:40	Antonio M. Calabro, Vincenzo Quaranta, Ignazio Dimino, IRA, Italian Aerospace Research Center	p. 713
	Smart Structure for SHM System Based on Vibrational Parameters Variation	
Quantification and Validation Chair: Robert Mah, NASA,USA Room 030		
13:00 ~ 13:20	B. Petitjean, S. Simonet, S. Barut, EADS CCR, Suresnes, France	p. 1127

	Impact Damage Detection on Aeronautical Composite Parts: Issues and Challenges	
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	FE Model Updating for Structural Damage Localization and Quantification in High-dimension SHM Problem	
13:40 ~ 14:00	A. M. CALABRO, L. MAZZOLA and C. CANEVA, Universita' di Roma, La Sapienza – Roma – Italy, Italian Aerospace Research Center CIRA – Italy	p. 1142
	Design, Integration, Validation and Calibration of a Sensor System for Smart Materials: Multidisciplinary Approach Using COTS Optic Fiber Sensors	
14:00 ~ 14:20	A.J.Croxford, P.D.Wilcox, B.W.Drinkwater and G. Konstantinidis University of Bristol	p. 1149
	Temperature Sensitivity Limitations for Guided Wave Structural Health Monitoring	
Special Session: HUMS for Rotorcraft Usage Credits Chair:Michael Shiao, FAA Room 305		
13:00 ~ 13:20	Dr. Richard "Pat" Anderson, Dr. Andrew Kornecki, Rachel Rajnicek, Embry-Riddle Aeronautical University	p. 1835
	Life Limiting Rationale for a Level D HUMS Utilized for Maintenance Credits	
13:20 ~ 13:40	Amrita Kumar, Roy Ikegami, Shawn Beard, Lien Ouyang, Pin Yu, Acellent Technologies	p. 1871
	Smart Patch System for Condition Based Maintenance of Rotorcraft Structures	
13:40 ~ 14:00	Mark Agnello, FAA WJH Technical Center	p. 1855
	HUMS System Design Issues for usage Monitoring on Older Rotorcraft	
14:00 ~ 14:20	Dy D. Le, FAA	p. 1862
	FAA Perspectives for Aircraft Structural Monitoring for Usage Credits	
14:20 ~ 14:40	Dr. Richard "Pat" Anderson, Dr. Andrew Kornecki, Rachel Rajnicek, Embry-Riddle Aeronautical University	p. 1845
	Certification Issues for a Level D HUMS Utilized for Usage Credits	
14:40~15:40	**Poster Session at Dorman Grove**	
15:40~17:10	**SHM in Action at Memorial Auditorium**	
18:50 ~ 22:00	**Banquet Dinner and Awards Ceremony** • **SHM Lifetime Achievement Award** • **Hans-Juergen Schmidt Award** • **SHM Person of the Year Award** • **Best Paper Award**	

The 6th International Workshop Structural Health Monitoring Stanford University 2007	**Technical Program September 13th**	
Morning Session		
Keynotes Chair: Victor Giurgiutiu, AFOSR Memorial Auditorium		
08:30 ~ 09:05	Mark Derriso, Air Force Research Laboratory	p. 44
	Why Are There Few Fielded SHM Systems for Aerospace Structures	
09:05 ~ 09:40	Paul Hess, The Office of Naval Research	p. 3
	Structural Health Monitoring for High-Speed Naval Ships	
Civil Infrastructures, Offshore Pipelines, and Power Plants: IV Chair:Cliff Lissenden, PSU, USA Room 002		
10:00 ~ 10:20	Dae-Hyun Kim, Jong-Jae Lee and Maria, Q. Feng, Seoul National University of Technology, KAIST, University of California Irvine	p. 299
	Structural Health Monitoring of Real Bridge by Using Novel Fiber Optic Accelerometer	
10:20 ~ 10:40	M. Bruns, Th. Nitschke-Pagel, K.Dilger, TU Braunschweig	p. 339
	Lifetime Prediction of weldments under variable amplitude loading with help of micromagnetic parameters	
10:40 ~ 11:00	Richard A. Livingston and Shuang Jin, Office of Infrastructure R&D, Turner-Fairbank Highway Research Center, FHWA, NDE Center, TFRHC/FHWA, Wiss, Janney, Elstner Associate, Inc.	p. 346
	Comparison of Numerical Simulations of Chaotic Behavior in Structural Health Monitoring of Cable-Stayed Bridge with Field Data	
11:00 ~ 11:20	Simon Hoffmann, Roman Wendner, Alfred Strauss, University of Natural Resources and Applied Life Science (BOKU), Vienna	p. 354
	Comparison of Stiffness Identification Methods for Reinforced Concrete Structures	
11:20 ~ 11:40	D.Y. Zhang and E.A. Johnson, University of Southern California	p. 307
	Structural Control System Design for Parameter Identification of Shear Structures	
11:40 ~ 12:00	W. Huang, R. Wang, X. Meng, L. Yao and B. Yang, Tongji University	p. 524
	Identification Studies on a Prototype Structural Health Monitoring System for the Nanpu Bridge in Shanghai, P. R. China.	
Aerospace, Aircraft, Rotorcraft, Launch Systems: IV Chair: Hasso Weiland, Alcoa, USA Memorial Auditorium		
10:00 ~ 10:20	James L. Blackshire, Steven A. Martin, and Jeong K. Na, AFRL/MLLP, NDE Computational Consultants, University of Dayton Research Institute	p. 203
	The Influence of Bond Material Type and Quality on Damage Detection for Surface-Bonded Piezoelectric Sensors	
10:20 ~ 10:40	Weiping Liu, Victor Giurgiutiu, Univ of South Carolina	p. 1592

	Finite Element Simulation of Piezoelectric Wafer Active Sensors for Structural Health Monitoring	
10:40 ~ 11:00	Jonathan Sumners, Kevin Champaigne, Invocon, Inc.	
	Wireless Data Acquisition System for Impact Detection and Structural Monitoring	p. 211
11:00 ~ 11:20	Hisao Fukunaga, Takao Umino and Ning Hu, Tohoku University	
	Impact Force Identification of CFRP Stiffened Panel under Multiple Loading	p. 177
11:20 ~ 11:40	ZHAO Hai tao,ZHANG Bo ming,WANG Rong guo,WU Zhan jun,WANG Dian fu, Harbin Institute of Technology	
	Monitoring of Composite Pressure Vessel Using Two Kinds Of Fiber Optic Sensors	p. 222
11:40 ~ 12:00	Gang Yan,Li Zhou,Fuh-Gwo Yuan, Nanjing University of Aeronautics and Astronautics, North Carolina State University	
	Identification of Impact Load for Composites Using Genetic Algorithms	p. 185
Special Session: Challenges and Lessons Learned in SHM Applications Chair: Mark Seaver, Naval Research Lab Room: 034		
10:00 ~ 10:20	K. Pran, A. Le Breton, G.Sagvolden, Light Structures AS, Hasleveien 38, NO-0571 Oslo, Norway	
	The Road from Protoype SHM for Defence to Commercial Product in Civilian Market	p. 1457
10:20 ~ 10:40	Liming W. Salvino and Thomas F. Brady, NSWCCD	
	Hull Structure Monitoring for High-Speed Naval Ships	p. 1465
10:40 ~ 11:00	Mark Seaver and Stephen T. Trickey, Naval Research Lab	
	Embedding Fiber Bragg Grating Arrays in Composite Propeller Blades	p. 1473
11:00 ~ 11:20	A. Milanese, P. Marzocca , J. M. Nichols , M. Seaver , S.T. Trickey, Clarkson University and Naval Research Laboratory	
	Joint Loosening Detection Via Output-Only Broad-Band Vibration Measurements: An Experimental Study	p. 1499
11:20 ~ 11:40	Weihua XIE, Boming ZHANG, Shanyi DU, Jianping Meng, Fuhong DAI, Harbin Institute of Technology	
	Experimental investigation of Bolt loosening Detection in Thermal Protection Panels at High Temperature	p. 1480
11:40 ~ 12:00	T. Ogisu, H. Soejima, H. Yoneda, Y. Okabe, N. Takeda and Y. Koshioka, Fuji Heavy Industries Ltd., The University of Tokyo, RIMCOF	
	Evaluation of the applicability for a damage growth detection system using an FBG sensor/AWG filter as the elastic wave receiver	p. 1491
Special Session: Bio-Inspired Sensor Networks Chair: Akira Mita, National Research Institute for Earth Science and Disaster Prevention Room 205		
10:00 ~ 10:20	Ken-ichiro Ishikawa, Akira Mita, National Research Institute for Earth Science and Disaster Prevention	
	Fine Time Synchronization System for Sensor grid	p. 1409
10:20 ~ 10:40	Yoshito Tobe, Yasuyuki Ishida, Yuichi Uehara, Masato Mori, Nayuta Ishii, Tokyo Denki University	
	Analysis of Human's Condition Using Wireless Sensors	p. 1416
10:40 ~ 11:00	Yoshihiro Nitta and Akira Nishitani, Ashikaga Institute of Technology, Waseda University	
	Bio-inspired Monitoring System Utilizing Piezoelectric Cables	p. 1423
11:00 ~ 11:20	Robert White, Robert Littrell, Karl Grosh, Tufts Univ, Univ of Michigan	
	Copying the Cochlea: Micromachined Biomimetic Acoustic Sensors	p. 1447
11:20 ~ 11:40	Ran Kudo, Yuuka Nakamura, Akira Mita, Hiroaki Harada, Keio University, Nikken Sekkei Ltd.	
	Performance Assessment of a Building with Passive Dampers using MIMO System Identification	p. 1431
11:40 ~ 12:00	Akira Mita, Osamu Iwasawa, Shuichi Ogawa, Keio University	
	Smart Sensor Networks for Biofication of Living Spaces	p. 1439
Special Session: Self-Diagnosis and Calibration Issues for SHM Chair:Jeong-Beom Ihn, Boeing Phantom Works; Co-chair:Hoon Sohn, KAIST, Korea Room 203		
10:00 ~ 10:20	Seth Kessler & Pramila Agrawal, Metis Design Corporation	
	Adaptive SHM Methodology to Accommodate Ageing, Maintenance and Repair	p. 1963
10:20 ~ 10:40	Sang Jun Lee, Hoon Sohn, Carnegie Mellon University, Korean Advanced Institute of Science and Technology	
	Reference-free Piezoelectric Transducer Self-diagnosis for Structural Health Monitoring Systems	p. 1947
10:40 ~ 11:00	Gyuhae Park, Timothy G. Overly, Charles R. Farrar, Los Alamos National Laboratory	
	Piezoelectric Active-Sensor Diagnostic and Validation Process for SHM applications	p. 1955
11:00 ~ 11:20	Martin Bach, Claus-Peter Fritzen, Benjamin Eckstein, Holger Speckmann, EADS Innovation Works, Airbus Deutschland	
	Self-Diagnostic Capabilities of Piezoelectric Transducers Using The Electromechanical Impedance	p. 1931
11:20 ~ 11:40	Seunghee Park, Gyuhae Park, Chung-Bang Yun, Charles R. Farrar, Korea Advanced Institute of Science and Technology, Los Alamos National Laboratory	
	Sensor Self-diagnosis Using a Modified Impedance Model for Active Sensing-based Structural Health Monitoring	p. 1923
11:40 ~ 12:00	J. D. Kearns, C. L. Davis and V. J. Mathews, Boeing	
	Sensor Health Diagnostics for Piezoelectric-based SHM Systems	p. 1939
Prognostics Chair: Shah Mahmood, Naval Surface Warfare Center Room 305		
10:00 ~ 10:20	Robert Valentine, Richard Holmes, and Matthew King, VEXTEC Corporation	
	Applications of Data Compression in Health Management Systems	p.1075
10:20 ~ 10:40	Ville Lämsä & Jyrki Kullaa, Helsinki University of Technology, Helsinki Polytechnic Stadia	
	Nonlinear Factor Analysis in Structural Health Monitoring to Remove Environmental Effects	p. 1092
10:40 ~ 11:00	Roger K. Youree, Jeffrey S. Yalowitz, Aaron Corder, and Teng K. Ooi, Instrumental Sciences, Inc., Missile Defense Agency	
	Multivariate Statistical Analysis Technique for Predictive Structural Health Monitoring	p. 1100
11:00 ~ 11:20	S. Mohanty , R. Teale, A. Chattopadhyay, P. Peralta, and C. Willhauck, Arizona State University	
	Mixed Gaussian Process and State-Space Approach for Fatigue Crack Prediction	p. 1108
11:20 ~ 11:40	I. Cole, P. Corrigan, W. Ganther, T. Muster, D. Paterson, D. Price, A. Scott, D. Followell, S. Galea, B. Hinton, CSIRO Manufacturing and Materials Technology Australia, CSIRO Industrial Physics, The Boeing Company, Phantom Works, DSTO, Australia .	p. 1083

	A novel system for corrosion monitoring, diagnosis and prognosis in aircraft structures	
Afternoon Session September 13th		
Civil Infrastructures, Offshore Pipelines, Power Plants: V Chair:Vladislav Las, University of West Bohemia, Czech republic Room 002		
13:00 ~ 13:20	Mehmet Celebi, USGS	
	Health Monitoring of Buildings Using Threshold Drift Ratios - Now an Established Method	p. 467
13:20 ~ 13:40	Shuang Jin and Richard A. Livingston, Nde Center, FHWA, WJE Inc. Office of Infrastructure,TFHRC/FHWA	
	Application of Polynomial Chaoses to Analyze the Nonlinear Behavior in Structural Health Monitoring of Highway Infrastructures	p. 501
13:40 ~ 14:00	Yoji OKABE, Kazuki NATORI, Nobuo TAKEDA, and Toshimichi OGISU, The University of Tokyo	
	Simplified Evaluation Method of Debonding Length in CFRP Bonded Structures Using Lamb Waves	p. 332
14:00 ~ 14:20	Hesheng Tang ,Mikio Fukuda and Songtao Xue, Tongji University,Kinki University	
	Particle Swarm Optimization for Structural System Identification	p. 483
14:20 ~ 14:40	M. Wooddell, G. Pickrell And T. K. Ooi, Virginia Tech	
	Development of Stochastic Optical Fiber Sensors for Structural Health Monitoring Applications	p. 435
14:40 ~ 15:00	Chun Liu, Xiaolin Meng, Lianbi Yao, Tongji University, China, The University of Nottingham, UK	
	A Real-Time Kinematic GPS Positioning Based Structural Health Monitoring System for the 32km Donghai Bridge in China	p. 1262
Special Session: Emerging Sensing Technologies for SHM II Chair: Francesco Lanza di Scalea, UCSD; Co-chair:Carlos E. Cesnik, University of Michigan, USA Memorial Auditorium		
13:00 ~ 13:20	Karim G. Sabra, Ankit Srivastava, Francesco Lanza di Scalea, UCSD	
	Structural Health Monitoring by Extraction of Coherent Guided Waves from Ambient Noise	p. 1637
13:20 ~ 13:40	Terrisa Duenas, Akhilesh Jha, Wei Lee, Robert Bortolin, Ajit Mal, Teng K. Ooi, and Aaron Corder, NextGen Aeronautics, UCLA and AMRDEC	
	Structural Health Monitoring with Self-Healing Morphing Skins	p. 1621
13:40 ~ 14:00	Timothy G. S. Overly and Gyuhae Park and Charles R. Farrar,Los Alamos National Laboratory	
	Development of Impedance-Based Wireless Active-Sensor Node for Structural Health Monitoring	p. 1660
14:00 ~ 14:20	H. GAO, J. L. ROSE and C. J. LISSENDEN, Penn State	
	Ultrasonic Guided Wave Mode Selection and Tuning in Composites Using Piezoelectric Phased Arrays	p. 1668
14:20 ~ 14:40	Andrei Zagrai and Hakan Çakan, New Mexico Institute of Mining and Technology	
	Magneto-Mechanical Impedance Technique for Dynamic Identification of Metallic Structures.	p. 1693
14:40 ~ 15:00	Steve Anastasio, Sibel Pamukcu and Mesut Pervizpour, Lehigh University	
	Chemical Selective BOTDR Sensing for Corrosion Detection on Structural Systems	p. 1701
Wired and Wireless Sensor Network, Interfaces, and Infrastructure: II Chair:Teng Ooi, Missile Defense Agency and Office of Naval Research, USA; Co-chair:Aaron Corder, Missile Defense Agency, USA Room 034		
13:00 ~ 13:20	Joerg F. Wagner and T. Oertel, University of Stuttgart	
	Generalizing Integrated Navigation Systems for Structural Health Monitoring	p. 1245
13:20 ~ 13:40	Joshua K. Olund, Alan J. Cardini, Gino P. Troiano Jr., Chengyin Liu, Eric Feldblum, Paul D'Attilio, and John T. DeWolf, University of Connecticut, Storrs, Connecticut, Connecticut Department of Transportation Research Division	
	Development and Implementation of a Solar Powered Wireless Monitoring System on a Truss Bridge in Connecticut	p. 1174
13:40 ~ 14:00	Christian U. Grosse, Markus Krüger, Steven D. Glaser, Greg McLaskey, University of Stuttgart and University of California Berkeley	
	Structural Health Monitoring Using Acoustic Emission Array Techniques	p. 1157
14:00 ~ 14:20	Piervincenzo Rizzo, Joseph Kabara,Vladimir Zadorozhny, Kent Harries, David Tipper, University of Pittsburgh	
	Stress Wave-Based Bridge Monitoring Using Wireless Sensor Networks	p. 1255
14:20 ~ 14:40	Giulia Lanzara, Jianmin Feng, Kevin Huang, Rostam Dinyari, Jong Yon Kim, Peter Peumans, Fu-Kuo Chang, Stanford University	
	Stretching of a Monolithic Silicon-based Sensor Network for Large Area Embedded Structural Health Monitoring	p. 778
Special Session: Damage Quantification Methods for Aerospace Structures Chair:Jeong-Beom Ihn, Boeing Phantom Works; Co-chair:Hoon Sohn, KAIST, Korea Room 205		
13:00 ~ 13:20	V Sharma, M Ruzzene, S. Hanagud, Georgia Institute of Technology	
	Automation in SHM Using Damage Measure and Laser Doppler Vibrometer	p. 1568
13:20 ~ 13:40	Jennifer E. Michaels, Thomas E. Michaels and Adam C. Cobb, Georgia Institute of Technology	
	Ultrasonic Monitoring of Structural "Hot Spots" During Full Scale Fatigue Tests	p. 1576
13:40 ~ 14:00	Christian Boller, The University of Sheffield	
	Monitoring Strategies, Performance and Assessment of Multi-Riveted Metallic Aircraft Panels Using Acousto-Ultrasonics	p. 1584
14:00 ~ 14:20	M. P. Desimio, S. E. Olson, J. A. Montes De Ocaand K. S. Brown, ATK, University of Dayton Research Institute, AFRL	
	SHM of Cracks and Corrosion in Aerospace Shell Structures	p. 280
14:20 ~ 14:40	Ankit Srivastava, Ivan Bartoli, Francesco Lanza di Scalea, Karim Sabra, NDE & SHM Laboratory	
	Global-Local Ultrasonic Method Applied to the Quantitative Detection of Bond Defects in Aircraft Panels	p. 1604
14:40 ~ 15:00	Jeong-Beom Ihn, Boeing Phantom Works	
	Lamb Wave Front-Back Scatter Method for Estimating Delamination Size in Composite Structures	p. 1612
Special Session: Autonomic Structures Chair:Daniel J. Inman, Virginia Tech Room 203		
13:00 ~ 13:20	P. M. Weaver, University of Bristol	
	Applications of Polymorphic Composites within Aerodynamic Structures	p. 1357
13:20 ~ 13:40	Dr. Ian Bond, Dr. Richard Trask, Gareth Williams, Hugo Williams, University of Bristol, ACCIS	
	Autonomic Self-Healing and Damage Visualisation in Fibre Reinforced Polymer Composites	p. 1364

13:40 ~ 14:00	Benjamin L. Grisso, Jina Kim, Justin R. Farmer, Dong S. Ha, and Daniel J. Inman, Virginia Tech	
	Autonomous Impedance-based SHM Utilizing Harvested Energy	p. 1373
14:00 ~ 14:20	Rye, P., Nemat-Naser, S., Univeristy of California, San Diego	
	Embedded Distributed Sensing Network: Integration Considerations and Findings	p. 1391
14:20 ~ 14:40	Steven A. Martin, Kumar V. Jata, NDE Comp. Consultants and AFRL	
	Artificial Neural Networks for Impact Location thru Transversely Isotropic Layers	p. 1381
14:40 ~ 15:00	T. N. Thanh, M. J. Perry and C. G. Koh, National University of Singapore	
	Moving Force Identification: A Time Subdomain Genetic Algorithm Approach	p. 1399
Special Panel Discussion Session:Structural Health Monitoring/Evaluation for High-Speed Naval Vessels Chair:Liming Salvino, Navy Surface Warfare Center Room 305		
13:00~15:00	Prof. Doug Adams, Purdue University	
	Automated structural diagnostics	5 min
	Prof. Fu-Kuo Chang, Stanford University	
	Design of built-in diagnostic systems for structural inspection	5 min
	Dr. Chuck Farrar, LANL; Prof. Mike Todd, UC San Diego	
	Collaborative efforts on SHM and Prognosis	10 min
	Prof. Masoud Ghandehari, Polytechnic	
	Chemical sensing for material health management	5 min
	Prof. Dan Inman, Virginia Tech	
	Smart materials and sensors	5 min
	Prof. Darryll Pines, University of Maryland	
	Signal processing and real-time SHM	5 min
	Prof. Jerry Lynch, University of Michigan; Prof. K Law, Stanford University	
	Wireless sensors	7 min
	Dr. Jon Nickels, NRL; Prof. Kevin Murphy, University of Connecticut	
	The importance of modeling and quantifying in damage detection problems	7 min
	Prof. Chris Earls, Cornell University	
	Hull SHM theoretic for decision support	5 min
Panel Discussion **Memorial Auditorium**		
15:15 ~ 16:30	**Demands and Challenges for SHM in Civil and Mechanical System Infrastructures** Moerator: Wieslaw Ostachowicz, Polish Academy of Science Panelists: Steven Chase, NHWA; Shah Mahmood, Naval Surface Warfare Center; Akira Mita, Kieo University; Fuh-Gwo Yuan, NCSU; Helmut Wenzel, VCE Holding GmbH; H. Felix Wu, NIST	
	i-gift give-away for panel participants	

Awards

SHM Lifetime Achievement Award

An individual in the SHM community who has championed SHM over their career by advancing the state-of-the-art through their meritorious accomplishments in research, applications, education or sponsorship of the discipline will be selected to receive the prestigious SHM Lifetime Achievement Award by a committee of researchers, educators and practicing scientists and engineers in conjunction with the International Workshop of SHM Program Committee.

Hans-Juergen Schmidt Award

Individuals in the SHM community, recognized for their outstanding leadership in advancing technologies in industry and government, will be selected by an Award Committee representative of the world-wide SHM community to receive during every SHM workshop (International Workshop on Structural Health Monitoring [IWSHM], European Workshop on Structural Health Monitoring [EWSHM] and Asia-Pacific Workshop on Structural Health Monitoring [APWSHM]) the SHM Hans-Juergen Schmidt Award.

SHM Person of the Year Award

A structural health monitoring person of the year (SHM-POY) will be selected by the editors and associate editors of Structural Health Monitoring: An International Journal. The Person of the Year should have made an outstanding contribution to the field of SHM that will benefit society. This contribution can be in the form of theory, analysis, applications, education, or other ways that support the discipline of SHM and benefit society. The award is meant to recognize accomplishments within the past year or few years.

Best Paper Award

The SHM Best Paper Award is presented to one or more individuals whose paper(s) are selected to have the highest quality and innovation from the Proceedings of the 2007 IWSHM.

Student Best Paper Award

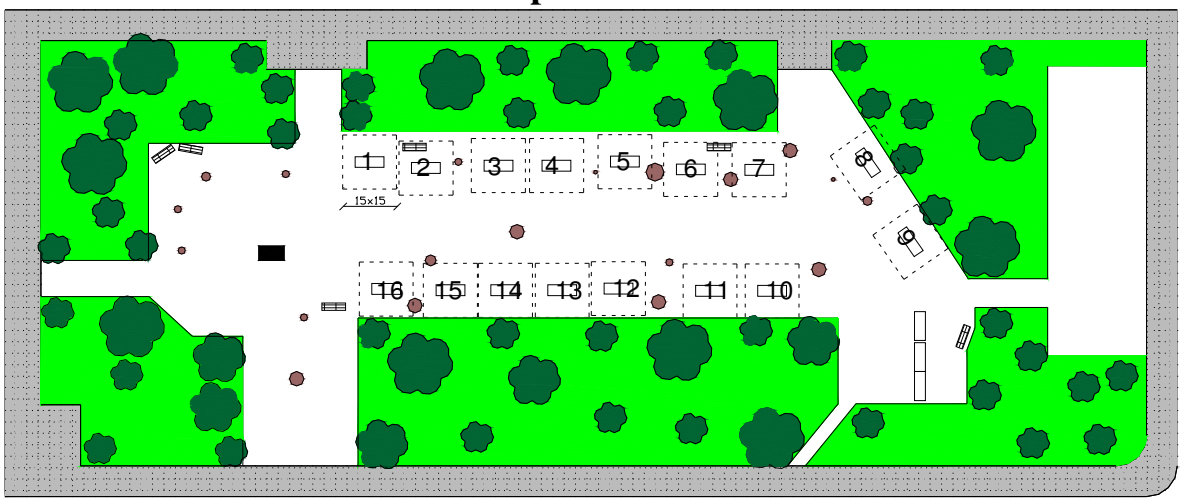
The IWSHM organizing committee is pleased to invite students to submit abstracts for the 2007 IWSHM Student Best Paper Award Competition. Papers will then be evaluated by a committee of experts from academia, industry, and the research community. Approximately 3-6 papers will then be selected to participate in the oral presentation competition at the workshop in September. Students will be evaluated during their presentation. 1st, 2nd, and 3rd place awards will be given out at the workshop.

SHM in Action

Company/Institute Name	Company/Institute Logo	Demo Description
Laboratory for Intelligent Structural Technology (LIST)		A 5- minute video presentation about two aspects of a wireless monitoring system will be illustrated. A dense wireless monitoring system installed on a full-scale structure will be shown by video.
Tongji University		Donghai Bridge Health Monitoring System (DHBHMS) is an internet based bridge health monitoring system. It has totally 478 sensors including FPG strain and temperature, accelerometer, cable force meter, GPS, etc. The real time information from the sensors will be displayed.
UCSD/LANL Collaborative Research		A video will be played featuring a small RC Helicopter which is being developed by UC San Diego and Los Alamos National Labs.
Structures and composites Laboratory (SACL)		A 5- minute video will be played introducing the concept of a structural health monitoring fastener consisting of a built-in conformable eddy current sensor film for in-situ detection of fatigue cracks in multi-layered bolt hole locations. Included in the video will be results obtained from real-time monitoring during a recent fatigue test of a multi-layer joint.
Smart Fibres Ltd		The demonstration will be presented about the FBG interrogator "Wx" developed by Smart Fibres under the European defence program AHMOS.
Micron Optics Inc.		A demonstration on the operation and application of optical fiber Bragg grating (FBG) sensors for strain, stress and vibration measurements in SHM applications will be made.
Intelligent Systems Center (ISC)		Wireless embedded system for SHM will be displayed. Embedded system measures temperature, water level, tilt, and acceleration and reports data via email, FTP, and SMS.
QPS photronics Inc.		Fast Diagnostic tool to identify structurally deficient Bridges by Two Wave Mixing Technology will be demonstrated. Two Wave Miixng (TWM) is a Hybrid solution combing the simple application of a piezoelectric actuator with QPS Vibro fiber TM technology.
Acellent Technologies Inc.		Live demonstrations of a complete SHM package consisting of a piezoelectric sensor network, lightweight hardware and integrated software for detecting impacts on a Thermal Protection System by displaying the location of impact.
MPA Stuttgart		Demonstration of the wireless sensor node system (based on MEMS and hybrid sensors) including recordings of acoustic emissions, strain, temperature, humidity. Presentation of a high-fidelity acoustic emission sensor.
Insensys Ltd		An embedded fibre optic acoustic laser system for detecting defects will be demonstrated.
Structural Monitoring Systems Limited		The principle behind the CVM (Comparative Vacuum Monitoring) technology will be outlined, including current implementations on metal and composite structures. A short demonstration of the new CVM Switch will be given.
MicroStrain, Inc.		Energy harvesting wireless sensors for SHM will be displayed. Breaking down the barriers of traditional sensors, MicroStrain's energy harvesting wireless sensors eliminate long cable runs as well as battery maintenance.
Los Gatos Research, Inc.		Los Gatos Research has developed a lock-in based laser demodulation technique for integrated fiber-optic strain and ultrasonic wave sensing. A laser locked-in-based FBG interrogation technique will be displayed to demonstrate real-time Lamb wave detection, temperature, and strain measurements.
VCE Holding GmbH		Permanent Ambient Vibration Monitoring applied at Industrial Facilities will be demonstrated. The presented investigations are based on the determination of the global condition of maintenance (the structure's integrity) as well as the load bearing capacity of a 200 m high industrial concrete chimney in the Czech Republic.

Company Exhibition

Exhibition Map in Dohrmann Grove



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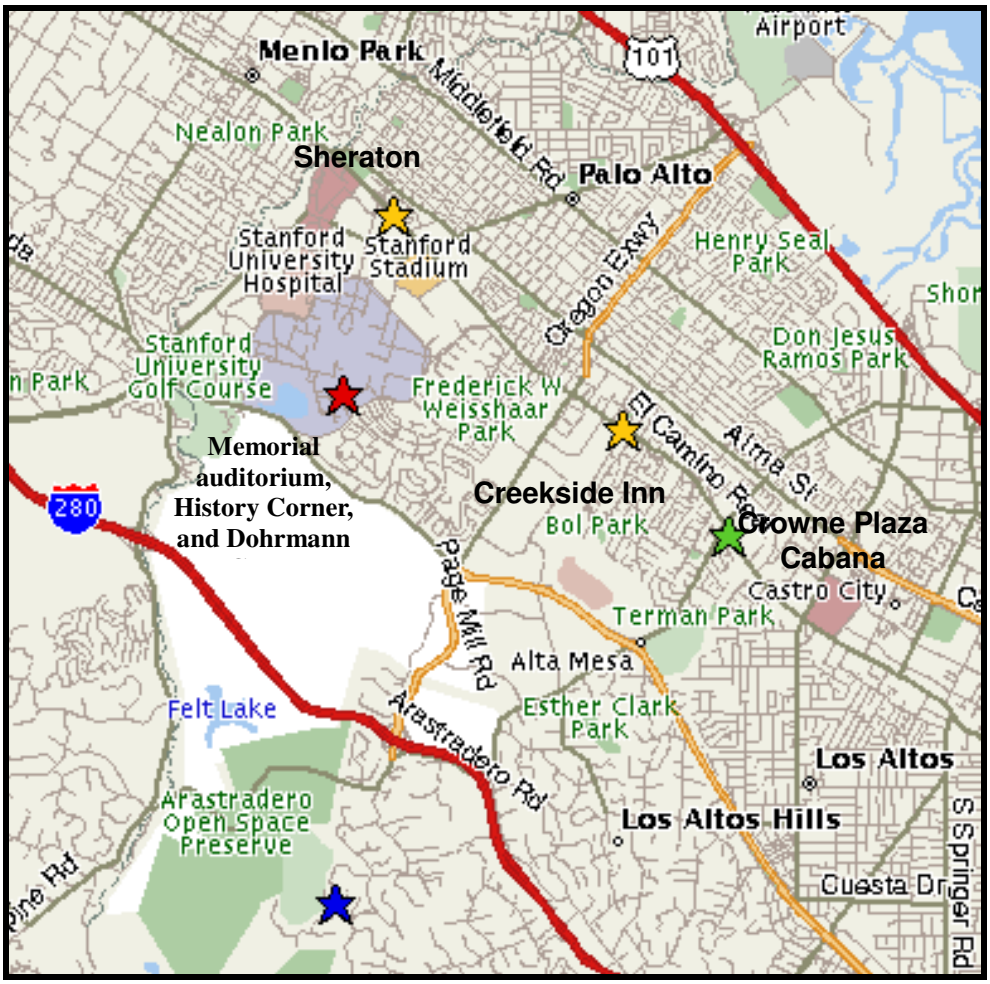
[2] Structural Monitoring
[3] Physical Acoustic
[4] IFOS
[5] As Monitoring
[6] Smart Fibers
[7] NEES@UCLA
[8] Wiley
[9] Structures Lab Stanford
[10] Metis Design
[11] Micron Optics
[12] QPS
[13] MPA
[14] Insensys
[15] BaySpec
[16] Micro Strain

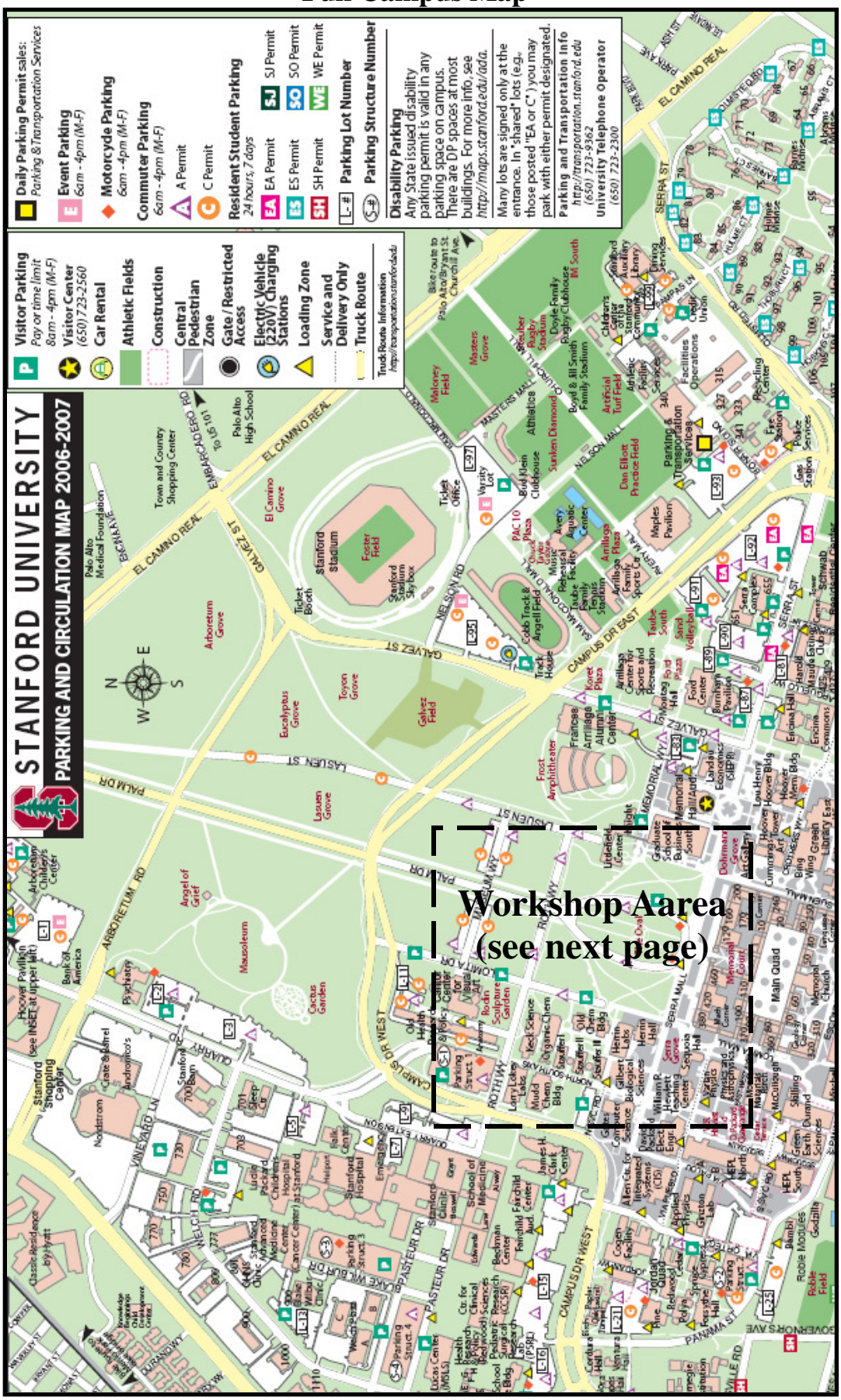
Workshop Sites

Site	Address	Phone
Memorial auditorium, History Corner, and Dohrmann Grove	Stanford, CA 94305	(650) 723-3466
Banquet Crowne Plaza Hotel Cabana	4219 El Camino Real Palo Alto, CA 94304	(650) 948-1800
BBQ Reception	Frost Amphitheater, Stanford, CA 94305	N/A
Crowne Plaza Hotel Cabana	4219 El Camino Real Palo Alto, CA 94306	(650) 352-1234
Creekside Inn	3400 El Camino Real Palo Alto, CA 94306	(650) 493-2411
Sheraton Hotel	625 El Camino Real Palo Alto, CA 94301	(650) 328-2800

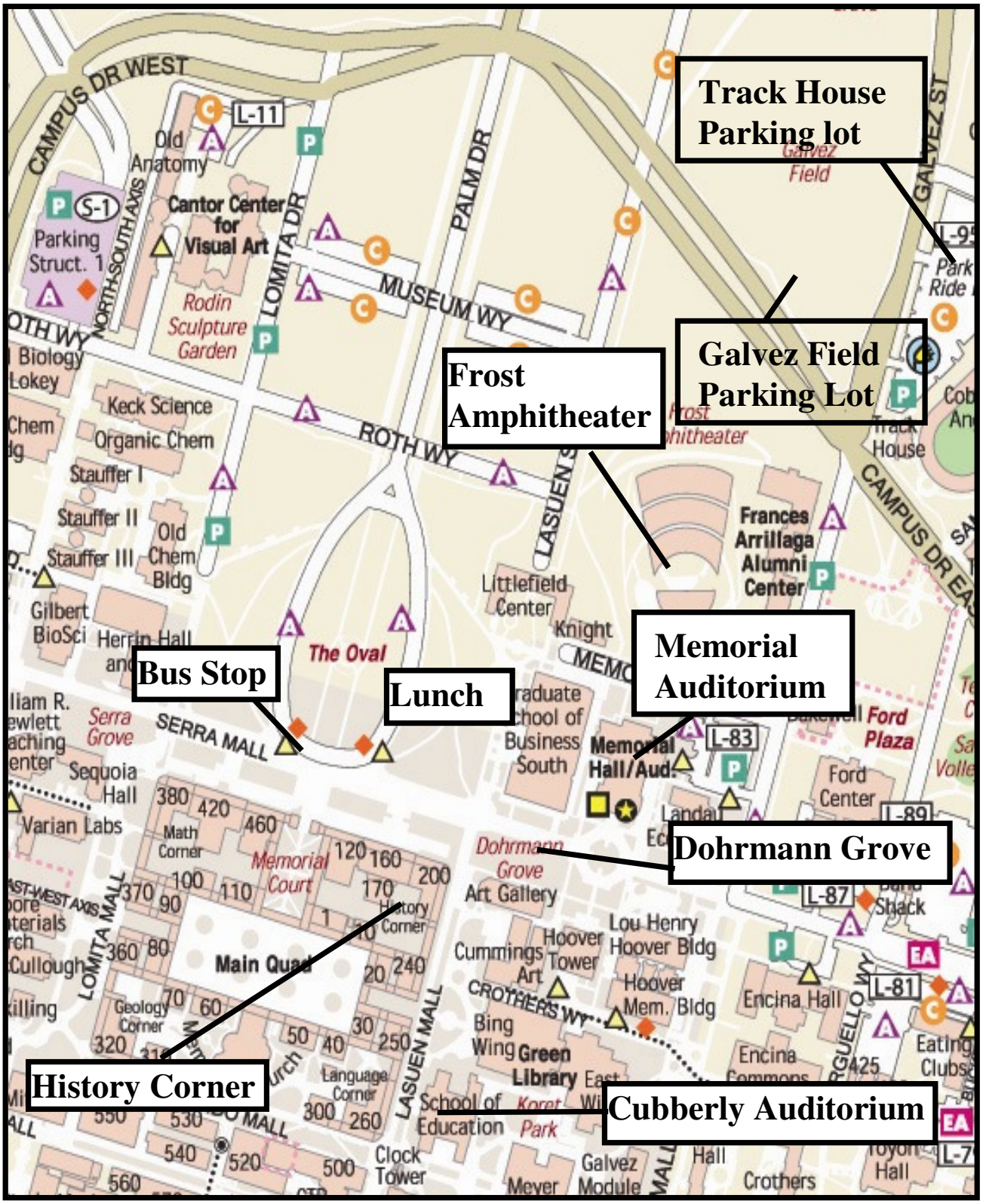
Map of Workshop Sites



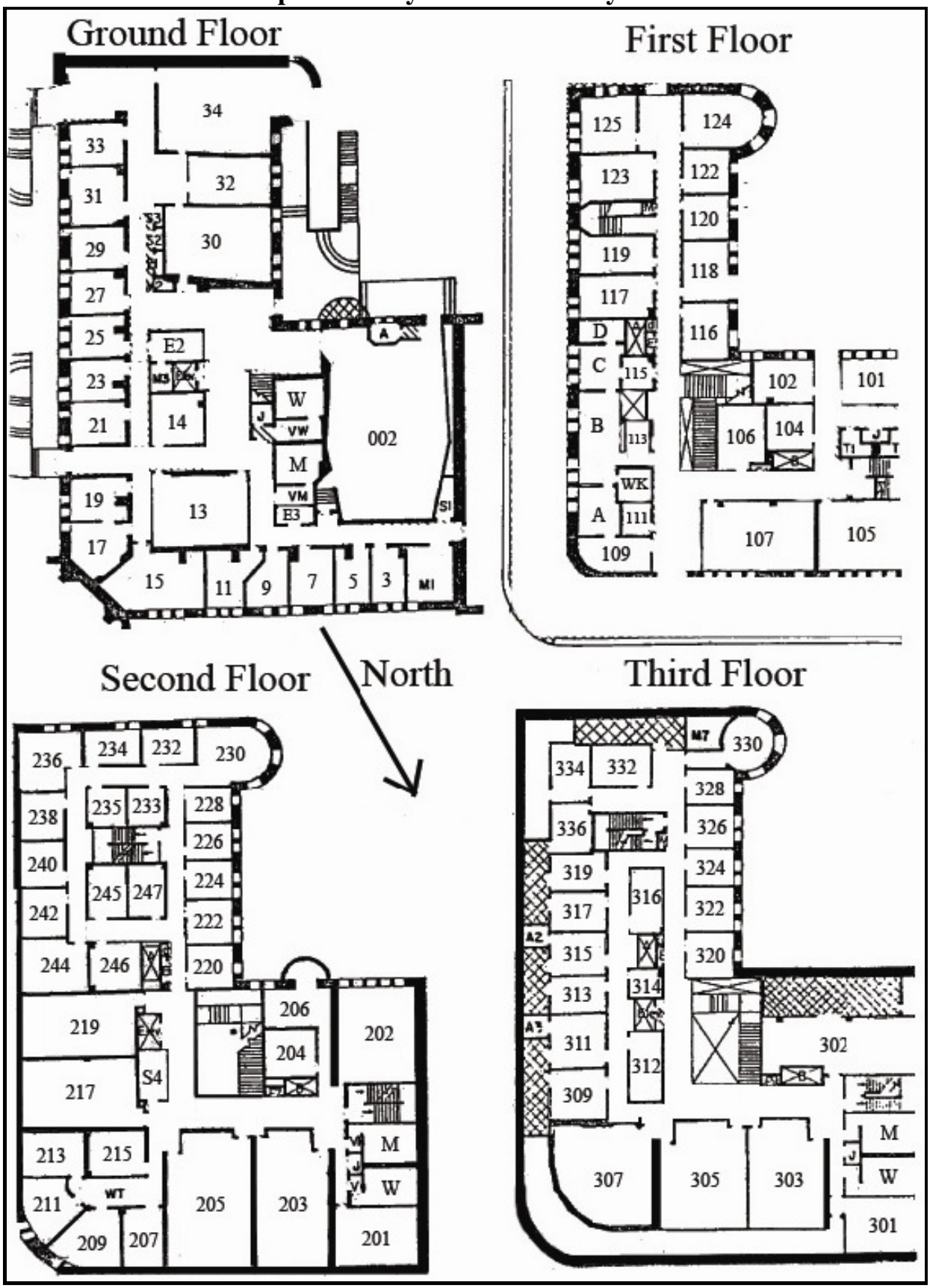
Full Campus Map



Enlarged Workshop Area



Map of History corner Room by Floor



Driving Directions to Workshop Area

- From Hwy 101:
  - Take the University Ave exit towards Palo Alto. Continue on University for 2 mi. University Ave enters Stanford Campus and becomes Palm Drive. Take Palm Dr. straight to The Oval (see workshop area map on preceding pages). Park at any of the A-permit locations around the oval**.
- From Hwy 280:
  - Take the Page Mill Rd/ Arastradero Rd exit towards Palo Alto. Turn Left onto Page Mill Rd. Go 1.4 mi, and turn Left onto Junipero Serra Blvd. Take next Right onto Stanford Ave. Turn Left on Bowdoin St. Turn Right onto Campus Drive East. Turn Left on Palm Drive. Take Palm Drive straight to The Oval (see workshop area map on preceding pages). Park at any of the A-permit locations around the oval**.
- From Sheraton, Crown Plaza Cabana, and Creekside Inn:
  - Take El Camino Real Northeast and turn left at University Ave. University Ave enters Stanford Campus and becomes Palm Drive. Take Palm Drive straight to The Oval (see workshop area map). Park at any of the A-permit locations around the oval**.

** See below for additional parking information.

On Campus Parking

If you choose to drive, parking permits are available from the workshop registration table. As is typical for a college campus, parking is limited and you are highly encouraged to take the workshop shuttle.

Due to other events on campus, parking will be very limited on Sept. 11. One day permits will be available for $5 for use in the ***Track House parking lot***. (See map – across from Galvez Field)

For Sept. 12-13, parking will be available at ***Galvez Field parking lot***. An IWSHM window sticker is required to park there, but covers both days, and can be purchased for $10 at the registration table.

Parking permits will also be available at the pre-registration Monday Sept. 10 at the Crowne Plaza Hotel. Purchasing permits there will save a walk to and from the parking lot, and is encouraged.

In addition to the conference registration table, parking permits can be purchased at- The Parking & Transportation Services office at 340 Bonair Siding (open 7:30-5)

Finally, there are parking permit machines in the Tresidder lot, in front of the Cantor Art Center, at 401 Quarry Road - Psychiatry, behind Memorial Auditorium, and at the Track House that accept credit cards, cash or coins. The receipt should be placed on the car dashboard.

Parking tickets range from $35 for a permit violation to $336 for illegally parking in a disabled space. More information about parking on Stanford's campus, including maps, is located on the Parking & Transportation website.

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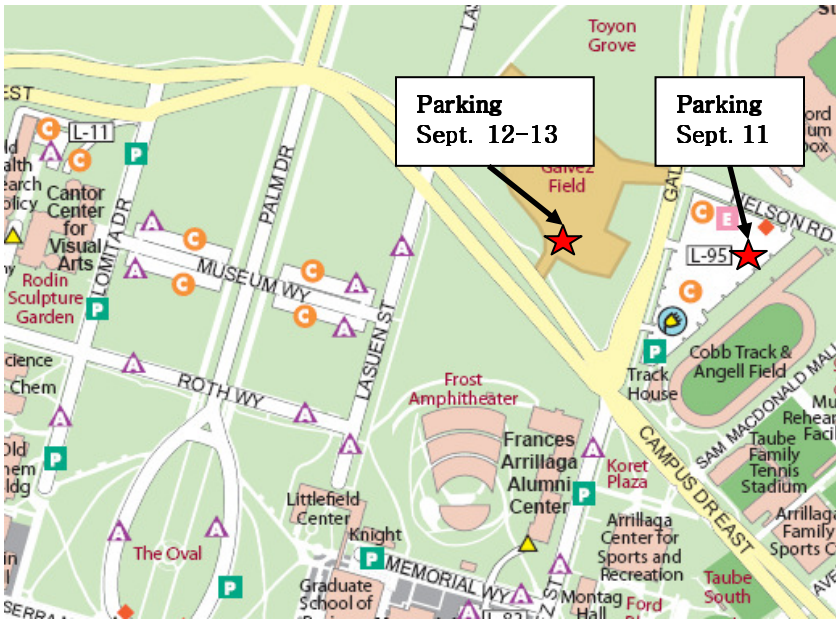

Workshop Internet Access

Access to Stanford wireless guest account will be open from Sept 10th to Sept 14th in the workshop area. Please use account name: IWSHM2007, Password: IW2007SHM.

Workshop Shuttle Schedule

Date	Session	Bus		Creekside	Crowne	Sheraton	Workshop
		1		7:00 AM	7:02 AM	7:11 AM	7:15 AM
		2		7:20 AM	7:22 AM	7:31 AM	7:35 AM
	Morning	3		7:35 AM	7:37 AM	7:46 AM	7:50 AM
		1		7:45 AM	7:47 AM	7:56 AM	8:00 AM
		2		7:55 AM	7:57 AM	8:06 AM	8:10 AM
		3		8:05 AM	8:07 AM	8:16 AM	8:20 AM
	Session	**Bus**		**Workshop**	**Creekside**	**Crowne**	**Sheraton**
		1		4:45 PM	4:53 PM	4:55 PM	5:04 PM
		2		5:00 PM	5:08 PM	5:10 PM	5:19 PM
Tuesday	Afternoon	3		5:10 PM	5:18 PM	5:20 PM	5:29 PM
		1		5:20 PM	5:28 PM	5:30 PM	5:39 PM
		2		5:30 PM	5:38 PM	5:40 PM	5:39 PM
09/11/07		3		5:40 PM	5:48 PM	5:50 PM	5:59 PM
	Session	**Bus**		**Creekside**	**Crowne**	**Sheraton**	**BBQ**
		1		6:30 PM	6:32 PM	6:41 PM	6:45 PM
	Evening	2		6:35 PM	6:37 PM	6:46 PM	6:50 PM
		3		6:40 PM	6:42 PM	6:51 PM	6:55 PM
		1		7:05 PM	7:07 PM	7:16 PM	7:20 PM
	Session	**Bus**		**BBQ**	**Creekside**	**Crowne**	**Sheraton**
		1		9:15 PM	9:23 PM	9:25 PM	9:34 PM
	Evening	2		9:30 PM	9:38 PM	9:40 PM	9:49 PM
		3		9:35 PM	9:43 PM	9:45 PM	9:54 PM
		1		9:50 PM	9:58 PM	10:00 PM	10:09 PM

Date	Session	Bus		Creekside	Crowne	Sheraton	Workshop
		1		7:10 AM	7:12 AM	7:21 AM	7:25 AM
		2		7:20 AM	7:22 AM	7:31 AM	7:35 AM
	Morning	3		7:30 AM	7:32 AM	7:41 AM	7:45 AM
		1		7:40 AM	7:42 AM	7:51 AM	7:55 AM
		2		7:50 AM	7:52 AM	8:01 AM	8:05 AM
		3		8:00 AM	8:02 AM	8:11 AM	8:15 AM
	Session	**Bus**		**Workshop**	**Creekside**	**Crowne**	**Sheraton**
		1		4:45 PM	4:53 PM	4:55 PM	5:04 PM
	Afternoon	2		5:00 PM	5:08 PM	5:10 PM	5:19 PM
Wednesday		3		5:10 PM	5:18 PM	5:20 PM	5:29 PM
		1		5:20 PM	5:28 PM	5:30 PM	5:39 PM
		2		5:30 PM	5:38 PM	5:40 PM	5:49 PM
09/12/07		3		5:40 PM	5:48 PM	5:50 PM	5:59 PM
	Session	**Bus**		**Sheraton**	**Creekside**	**Crowne**	
		1		6:40 PM	6:46 PM	6:48 PM	
	Evening	2		6:45 PM	6:51 PM	6:53 PM	
		3		6:50 PM	6:56 PM	6:58 PM	
		1		7:00 PM	7:06 PM	7:08 PM	
	Session	**Bus**		**Crowne**	**Sheraton**	**Creekside**	
		1		8:45 PM	8:54 PM	9:00 PM	
	Evening	2		9:00 PM	9:09 PM	9:15 PM	
		3		9:05 PM	9:14 PM	9:20 PM	
		1		9:10 PM	9:19 PM	9:25 PM	
Date	**Session**	**Bus**		**Creekside**	**Crowne**	**Sheraton**	**Workshop**
		1		7:15 AM	7:17 AM	7:26 AM	7:30 AM
	Morning	2		7:30 AM	7:32 AM	7:41 AM	7:45 AM
		1		7:45 AM	7:47 AM	7:56 AM	8:00 AM
Thursday		2		8:00 AM	8:02 AM	8:11 AM	8:15 AM
09/13/07	**Session**	**Bus**		**Workshop**	**Creekside**	**Crowne**	**Sheraton**
		1		4:00 PM	4:08 PM	4:10 PM	4:19 PM
	Afternoon	2		4:15 PM	4:23 PM	4:25 PM	4:34 PM
		1		4:30 PM	4:38 PM	4:40 PM	4:49 PM
		2		4:45 PM	4:53 PM	4:55 PM	5:04 PM